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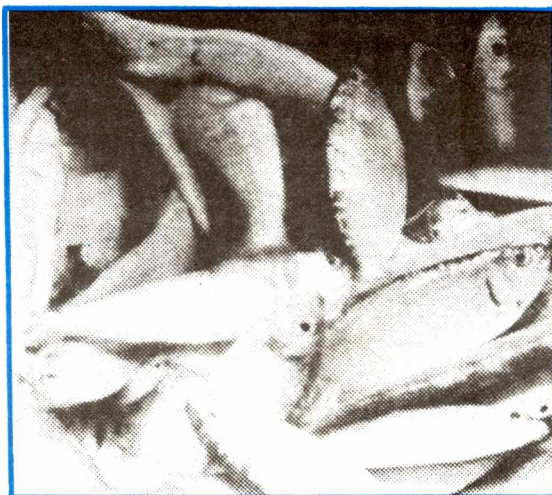
Why not both?

Mangroves vs Ponds

Aquaculture has contributed 27% to the total fish production in 1981. The high demand for fish prompted the government to encourage conversion of mangroves into fishpond to increase production.

Mangroves have always been the target of conversion into fishpond and other developments because of the belief that they are wastelands. However, JH Primavera in 1992 reported that each hectare of an unmanaged mangrove produces as much as \$11,300 a year at par with the most profitable intensive shrimp farming that nets \$11,600 per hectare per year.

The natural functions of mangrove forests are traded-off when they are converted to fishponds for aquaculture.



To save the remaining mangrove forest, SEAFDEC/AQD Chief Efren Flores and University of Philippines in the Visayas Chancellor Arsenio Camacho as members of the **Task Force on Mangroves**, proposed to raise the fishpond rentals from 1,000 to 6,000%. This is to reflect the true value of mangroves.

Despite the many benefits and goods from mangroves and increase of rentals of fishponds to discourage conversion, fishpond development from mangroves is still being done.

This issue is a follow-up of AFN July-August 1995 which featured the value of mangroves. Here the value and benefits from fishpond is presented and the comparative economic analyses of both are highlighted to give the future pond developer a serious thought before converting any more mangroves.



Shrimp pond culture in the Philippines

Shrimps and prawns have become a multimillion dollar industry in the Philippines with exports (mainly to Japan) increasing from 179 t valued at US\$149,000 in 1968 to 30,460 t worth \$273 million in 1991. Asian countries contributed 80% of the worldwide production of cultured shrimps totalling around 690,100 mt in 1991. Ecologists, however, have warned aquaculturists regarding the effects of the industry's growth on coastal pollution.

Of the total 1991 aquaculture production of 692,400 mt, 42% comes from fish and shrimp yields in brackishwater ponds, and 13% from freshwater ponds, pens, and cages and the rest from seaweeds and mollusc culture in marine waters.

History of brackishwater pond culture

The beginnings of brackishwater pond culture in Southeast Asia can be traced to either the islands of Madura or East Java in Indonesia almost 600 years ago. The first recorded fish-pond in the Philippines was in Rizal Province in 1863, the culture spreading out around the Manila area for at least half a century.

Milkfish monoculture was introduced first at low, followed by increasingly higher densities. In the Philippines, the major cultured shrimp species is the giant tiger shrimp (*Penaeus monodon*). Its production has steadily increased from 1,400 t in 1980 to 47,600 t in 1990, whereas the yearly marine catches from 1968 to 1987

fluctuated between 10,000 and 40,000 mt, with an average of around 24,000 t. In 1989, semi-intensive and intensive ponds produced over 65% of the total *P. monodon* harvests.

Shrimp culture systems

As with other aquaculture systems, shrimp grow-out farms may be classified into four categories - traditional, extensive, semi-intensive, and intensive - characterized by increasing stocking rates supported by corresponding feed and water management inputs.

Comparative economic analysis

The primary motivating factor behind the shift of traditional milkfish and shrimp farmers to intensive shrimp culture, is greater profitability. The assumption of more profits can be verified by looking at the comparative economics of the different culture systems.

Intensive farming is characterized on a per kilogram basis by low fixed cost because of high productivity per area, but high variable cost mainly for feeds and water quality maintenance. Profitability depends on market price and production costs. If market prices are favorable, intensive farming remains profitable from the sheer volume of production; once prices drop, so does profitability. Semi-intensive farms will survive because of relatively higher productivity at lower production costs. In 1988, B. Posadas found that

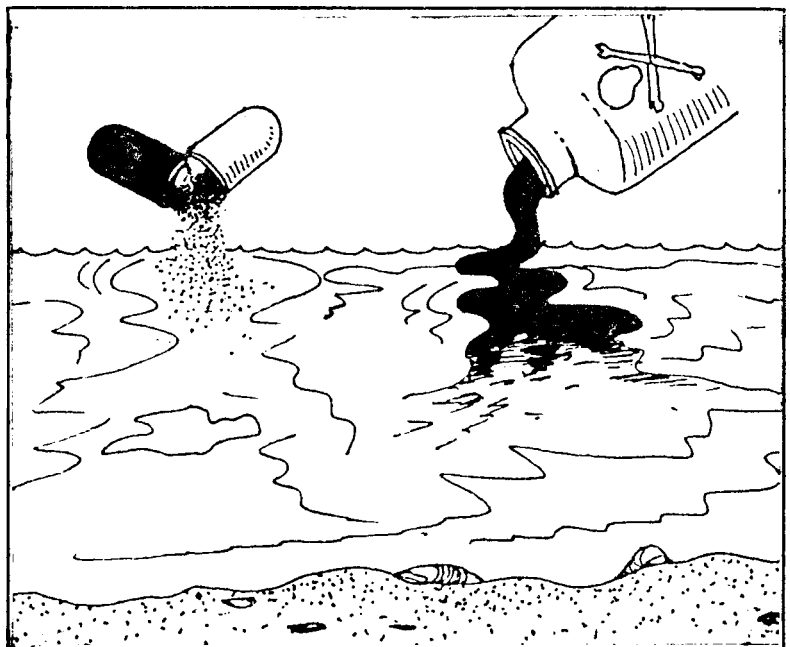
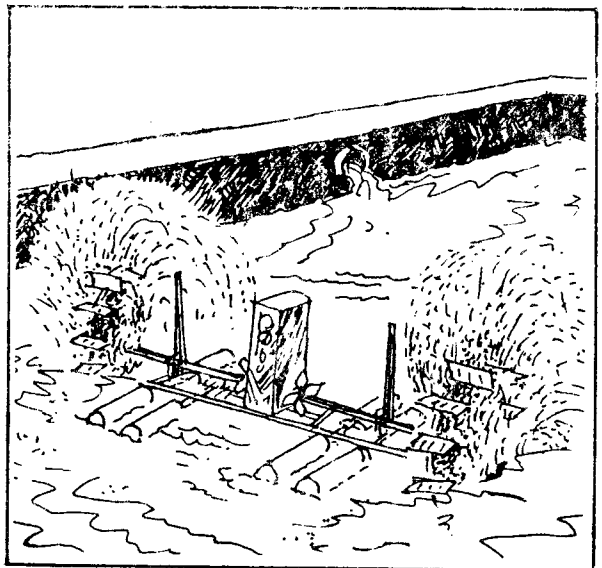
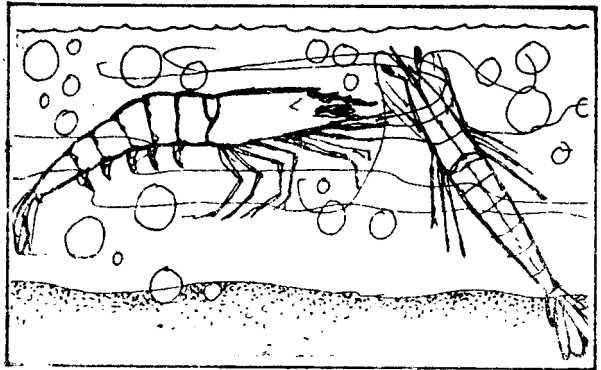
Table 1. Economic comparison of extensive, semi-intensive, and intensive shrimp farms in Indonesia

Parameter	Management system		
	Extensive	Semi-intensive	Intensive
Land purchase	No	No	Yes
Capital cost (US\$/ha)	None	3,280-3,825	27,322
Production (kg/ha)	179	1,000	5,625
Operating cost (US\$/ha)	328	2,721	19,125
Gross profit (%/ha)	929	5,465	30,738
Net profit (US\$/ha)	600	2,743	11,623
Breakeven price (US\$/kg)	1.83	2.72	3.40

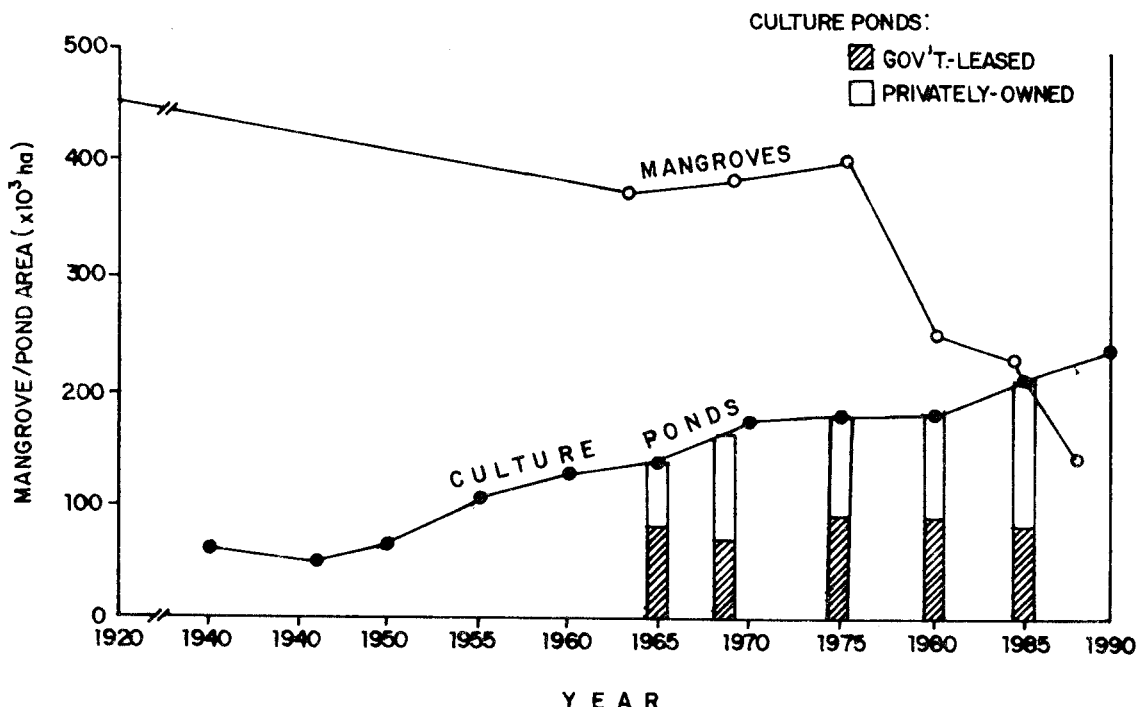
intensive farms had higher profitability compared to semi-intensive farms on a per hectare basis (P537,000 vs. P240,000) (US\$1:Phil. Pesos 20.6) but a lower profit per kilogram (P34.12 vs. P39.72). (See page 10 for more on economics of different culture systems.)

In Indonesia, gross and net profits increase with intensification of culture, but so does the breakeven price (Table 1). Intensive and semi-intensive farms can remain profitable only at selling prices of \$4.37/kg and \$3.28/kg, respectively. Although traditional and extensive farmers in the Philippines, Vietnam, Sri Lanka, and Bangladesh managed to survive the 1989 *P. monodon* price collapse, many intensive operators in Southeast Asia and Taiwan were pushed to bankruptcy by high production costs and payments due on development loans.

In 1983, intensive shrimp farming in the Philippines required a capital outlay of P0.5 million ha⁻¹ (\$1:Phil P11.1) for pond development compared to only P25,000/ha for semi-intensive ponds. Dependent on tidal flow, traditional and extensive farms utilize existing coastal ponds; no land purchase is involved. In contrast, heavy machinery used to construct intensive ponds requires a firm substrate, therefore more inland locations need to be acquired. Similarly, capital costs in Indonesia increase from nil to \$27,322/ha, and annual operating costs from \$32/ha to \$19,125/ha with the shift from extensive to intensive shrimp culture.



Intensive prawn farming and effects on the environment: artificial feeds, high DO requirements, massive water/power requirements, use of antibiotics, pesticides and other chemicals.



Total mangrove area and brackishwater culture ponds in the Philippines. (redrawn by E. Ledesma)

Ecological impacts

The single most important consequence of brackishwater aquaculture in the Philippines is the loss of mangrove ecosystems. Other ecological effects, such as pollution caused by organic matter and nutrient overloading, chemical toxicity, and public health risks, are unique to intensive shrimp farming. In addition to material from the Philippines, the discussion draws from the experience of other Asian countries.

Loss of mangrove ecosystems

A total 58% of fishpond were converted from mangroves in the Philippines as of the late 1970s. In 1969-1984, the reduction in mangrove areas in Ecuador was mainly due to the construction of 21,587 ha of shrimp ponds compared to only 1,152 ha for urban expansion. Around 50% of the total denuded mangrove area of 171,472 ha in Thailand for the period 1961-1987 was converted into ponds. The Department of Fisheries of Malaysia estimates that 21,000 ha of mangroves could be opened up for prawn culture by the year 2000.

The continued expansion of fishponds remained in spite of the proconservation stance of the DENR. Until 1984, the yearly Fisheries

Statistics published by the BFAR continued to list mangroves under a section entitled "Swamp-lands available for development."

Mangrove loss to shrimp ponds which was facilitated by western economic assistance (IBRD, ADB, World Bank, and other multilateral development agencies) may be the dominant cause of the well-documented decline in the abundance of wild shrimp postlarvae in Ecuador. Various studies show a positive correlation between fish or shrimp catches and mangrove or intertidal areas in different parts of the world. They demonstrate a mathematical relationship whose ecological basis may be related to the exchanges of detritus, nutrients, and fauna between mangrove and nearshore habitats.

Organic loading and pollution

Organic matter that settles at the bottom of shrimp ponds forms a thick foul-smelling sludge layer which, after harvest, is either scraped off, or dried and tilled at the bottom to hasten decomposition. Farmers in a rush to make 2.5 to 3 crops a year find this fallow period too time-consuming and instead remove the offensive bottom layer which, eventually loses organic matter and gets deeper.

Intensive monoculture ponds of shrimp or

fish show the same general trends as a stressed ecosystem following pollution.

Nutrient enrichment and eutrophication

Assimilation efficiency of food nitrogen is only 45% in cultured *P. monodon*. At FCR of 2, around 87 kg of nitrogen and 28 kg. of phosphorus per ton of shrimp harvested are produced as wastes. Mean concentrations of water quality parameters in Hawaiian shrimp ponds were generally higher in effluent than in influent water. Nitrogen and phosphorus water levels in wastewater discharged from shrimp ponds in Thailand were significantly higher compared to

inflow water. Loadings of dissolved nitrogen are important because nitrogen is generally regarded as the phytoplankton-limiting nutrient in marine waters. Yellowtail feces may stimulate growth of the red tide-forming dinoflagellate.

Prevention and Control of Wastes

Prevention and control are the two major approaches in addressing the problems of organic effluents, nutrient enrichment, and diseases in intensive aquaculture. Prevention means good management and husbandry: proper site selection, pond design, pond preparation, water and feeding management.

	Intact/ managed mangrove system	Brackishwater pond culture			
Milkfish culture		Shrimp farming			
		E	S-I	I	

A. Values					
1. Communal ownership of resources	+	-	-	-	-
2. Mangrove products	+	-	-	-	-
3. Coastal protection	+	-	-	-	-
4. Nearshore fisheries production	+	-	-	-	-
5. Domestic food supply	+	+	-	-	-
6. Foreign exchange	±	-	+	+	+
7. Income	+		Limited to middle and upper income classes		
8. Employment	+		Limited to technical and managerial expertise		
9. Competition for land, credit, etc.	-	+	+	+	+
B. Problems					
1. Pollution (inside and outside pond system)	-	-	-	-	+
2. Chemical toxicity	-	-	-	-	+
3. Public health risks	-	-	-	-	+
4. Displacement of native species	-	-	-	-	+
5. Spread of parasites and diseases	-	-	-	-	+
6. Water and soil salinization	-	-	-	-	+

Ecological & socioeconomic values (A) and problems (B) of brackishwater pond culture compared with intact or managed mangrove system. (+ denotes presence; - denotes absence or loss; E - extensive; SI - semi-intensive; I - intensive)

Socioeconomic effects

Some socioeconomic effects, such as loss of goods and services resulting from mangrove conversion, are consequences of brackishwater pond culture in general whether for milkfish or

shrimp. However, water salinization and land subsidence, decline in domestic food crops, and competition for credit, land, and other resources are recent occurrences associated with shrimp farming.

Total mangrove and brackishwater culture pond area in the Philippines, 1920-1990

Year	Mangrove area (ha)	Brackishwater culture ponds		Remarks
		Total area (ha)	Increase (ha/yr)	
1920	450,000			
1940		60,998	1,176 (1941-1950)	
1950		72,753	5,050 (1951-1960)	Fishpond boom Creation of Bureau of Fisheries; US\$26 million from IBRD for fishpond development
1960		123,252	4487 (1961-1970)	
1965	362,334			
1970	288,000	168,118	811 (1971-1980)	Conservation phase National Mangrove Committee (1976); Forestry and Fisheries Decrees; 79,000 ha mangroves allocated for preservation after nationwide inventory
1980	242,000	176,231	4,668 (1981-1990)	Shrimp fever Extension of hatchery technology; commercial production of fry and feeds; introduction of intensive farming; \$21.8 million ADB project for shrimp and other aquaculture
1988	149,300			
1990		222,907		

Source: Primavera-Honculada, J. "A Critical Review of Shrimp Pond Culture in the Philippines". *Reviews in Fisheries Science*, 1(2): 151-201 1993.

Shrimp Culture and the Environment

Shrimp culture have caused serious economic losses to shrimp farmers. Aquaculture production of shrimps in 1993 was only 609,000 t, 16% less than in 1992. The decline was due to major collapse in China (from 140,000 t in 1992 to 50,000 t in 1993), a decrease in Indonesian production from 130,000 to 80,000 t, and a further slight decline in Taiwan from 30,000 to 25,000 t.

Problems of shrimp farming industries widely attributed to disease outbreaks linked to environmental deterioration, have raised major questions about the sustainability of shrimp farming. Shrimp culture may bring large profit but if badly planned and managed, may cause irreversible environmental damage, lost opportunities, and rehabilitation costs that can easily lead to net economic loss. The principal natural resources required for shrimp culture are land, water, and biological resources, including seed and feed. The available resources and the manner in which they are used determine in large part the economic and sustainability of shrimp farming.

Land requirements

Shrimps are cultured almost entirely in land-based ponds. The area of land required depends on the culture system. Traditional exten-

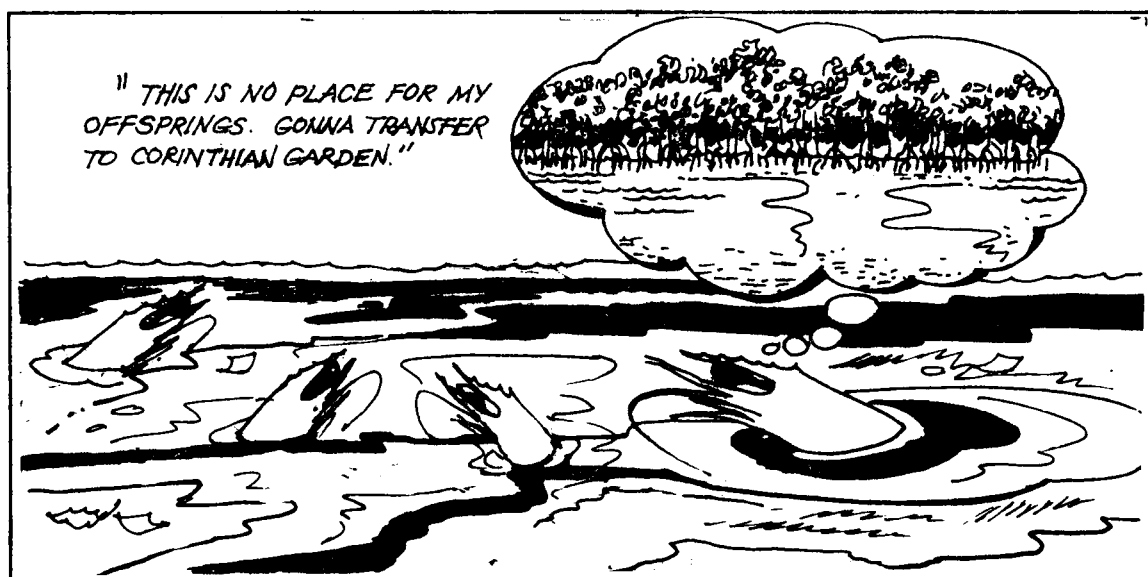
sive culture system occupies large land areas, with ponds often 2-20 ha, sometimes, even 200 ha. Semi-intensive and intensive culture systems tend to be in smaller ponds.

The price of coastal land depends on its availability. Limited coastal land and higher land prices, as in Taiwan, stimulate development of more intensive shrimp culture systems to get greater economic returns per unit area. In countries such as Indonesia and Vietnam, with cheaper and more abundant coastal land, semi-intensive and extensive systems predominate.

The type of land used for shrimp farming affects the success of shrimp farming itself and the kinds of environmental impacts and conflicts with other coastal resource users. The traditional preference for low-lying coastal wetlands has changed to an industry preference for supra-tidal land where ponds are cheaper to construct and drain, and the soil are normally better.

Salination of soils as a result of shrimp farming devaluates the agricultural land. In Thailand 3,344 ha of shrimp ponds had led to salination of 1,168 ha of agricultural land.

The decline of the shrimp industry in Thailand since 1989 was due to over-production, water pollution, and inadequate water supply.



Mangroves and shrimp culture.

The impact of shrimp culture on mangroves has received considerable attention being one of the coastal activities leading to the loss of the region's mangroves. However, the recent semi-intensive shrimp culture has occurred in non-mangrove areas, or in mangrove areas earlier cleared for extensive shrimp or fish culture, or other purposes. In China (the major shrimp producer in 1991), shrimp ponds are mostly in non-mangrove areas.

In Malaysia, shrimp farms have encroached into mangrove reserves while in Indonesia, most of the estimated 200,000 ha of shrimp ponds have been converted from mangrove forests. The total pond area is just 5% of the massive Indonesia mangrove resource of 4,251,011 ha, but construction of ponds for shrimp and milkfish culture has contributed to very significant local denudation in Java, Sulawesi and Sumatra. In the Philippines, a combination of shrimp and milkfish culture is responsible for the 60% loss of the mangrove areas.

In Thailand, 38.3% of mangrove areas lost between 1979 and 1986 were used for aquaculture. Shrimp ponds in some parts of the country have certainly encroached in mangrove areas, but other major shrimp farms are in areas with limited mangroves, such as Songkhla in the south. Some of the problems that emerge where there is large-scale conversion of mangroves to shrimp ponds can be seen in the Mekong Delta of Vietnam. Loss of the mangroves has serious implications for the sustainability of various coastal activities. The productivity of some coastal fisheries appears to be positively correlated to the abundance of mangrove forests adjacent to the fishing grounds. In Thailand, fishermen reported declines in catches due to restricted

access to previously accessible mangrove areas.

In Bangladesh, expansion of shrimp farming into mangrove areas has reduced fish catches and the socioeconomic condition of traditional

coastal fishermen. The loss of life and structural damage caused by the 1991 cyclone in southeastern Bangladesh may have been made worse by the earlier loss of mangroves; and coastal shrimp ponds themselves suffered severe damage. The economic impacts of mangrove destruction ultimately can be very significant and may far outweigh the short-term benefits from conversion to shrimp ponds.

There is a growing realization that mangroves themselves can contribute to the sustainability of aquaculture. Certainly, pond construction should not proceed indiscriminately in mangrove areas. The traditional extensive culture method uses up large areas of mangrove but has very low productivity in return. One hectare of mangroves can yield 767 kg of wild fish and crustaceans, more than the yields in extensive system (usually less than 500 kg/ha/yr).

The shrimp ponds on mangrove land often support profitable shrimp culture for only a short period. Mangrove areas are often not the places to build sustainable aquaculture farms. In extensive culture systems, loss of mangrove nursery areas can affect the supply of postlarvae for the ponds, a trend that has appeared in Bangladesh and may be threatening the sustainability of traditional shrimp culture in the Mekong Delta of Vietnam. In semi-intensive or intensive shrimp culture, acid sulfate soils common in mangrove areas may affect farm sustainability.

"Environmental deterioration was linked to the intensification of shrimp culture and the overloading of coastal waters with pond effluents and domestic and industrial discharge."

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Prawn farms threaten Mindanao's water supply

The expansion of prawn farms in the foreshores of Davao Gulf and Sarangani Bay in Mindanao is threatening the water supply of the island. Davao Gulf and smaller Sarangani Bay - 50 kilometers to its west, both of which open into Mindanao sea, are important fish and crustacean sources and provide livelihood for thousands of fisherfolk.

Large parts of the area are now "mangled" with crisscrossing concrete dikes and chemically laced water. A remaining 38-ha mangrove forest which used to be a paradise for fisherfolk has been converted into prawn farms. Its mangroves breed many kinds of shallow-water fishes, crustaceans and seashells. Mangroves were uprooted and coral reefs destroyed. Toxic chemicals to flush the farms were being released into the sea.

A much bigger shrimp farm, a 400-ha Sarangani Aquatic Resource, Inc. exports prawns mostly to Japan.

In another town, a Moro ethnolinguistic group had to give way to another prawn farm.

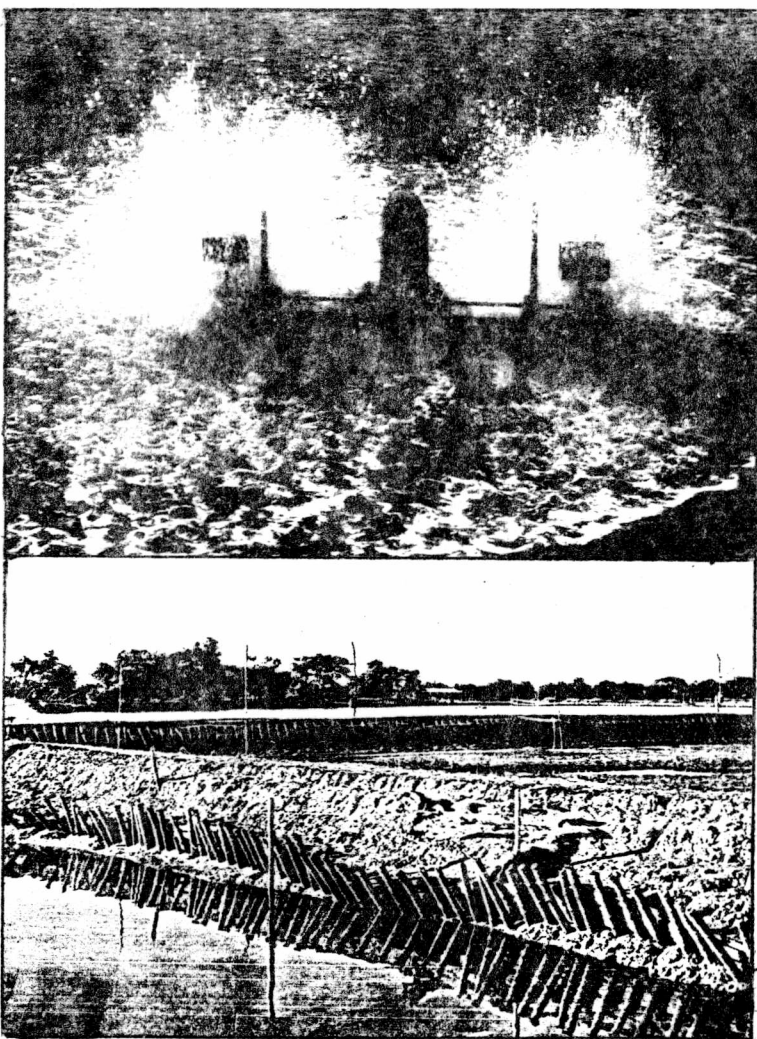
In Davao City, Mayor Rodrigo Duterte recently banned free-flowing wells commonly used in prawn farms. Diggers of new wells will also have to get city hall permits. The orders were issued after city authorities found that operations of a big prawn farm were endangering the city's water supply.

The City Water District official warned that although the effect is not yet apparent, prawn farms are putting the city's water resources in peril. He cited other areas in the country which went all out for prawn production and damaged their water supply.

Davao and Cotabato residents were also warned against "dried-up riverbeds, bald mountains, devastated mangroves, and waterless future." Both have destroyed forests and now, prawn farms for which the mangroves are being converted are viable for less than 10 years.

Sarangani Bay was covered with rich mangrove forests some 20 years ago.

Source: *The Sunday Chronicle*, August 22, 1993,



Shrimp farms - putting the water supply in peril.

Mangroves to aquaculture

For the Asia Pacific countries, the major objectives for mangrove development are increasing resource production, conserving/sustaining resource production, equity in benefits and better resource management.

Aquaculture then can increase resource production and enhance the equity in benefits from the resource. The yield of shells is 979 kg/ha/yr and that of sea cucumber is 297 kg/ha/yr. Catches for shrimps and fishes are generally no more than 1,000 kg/ha/yr. But using high intensity aquaculture methods, production in kg/ha/yr of the following are attainable in mangrove areas: crustaceans, 10,000; fishes, 10,000; and oysters, 5,000.

Recommendations of strategies regarding the further conversion of mangrove forests to fishponds and the management of existing fishponds for the culture of various aquatic species will be based on the results of the economic analysis.

ECONOMIC FEASIBILITY ANALYSIS

Methods of evaluation

Approaches have been proposed for alternative strategies for allocation of mangrove areas for competing uses. A prerequisite for this consideration is the economic feasibility of an alternate strategy. Aquaculture projects in mangrove swamps are evaluated for their economic feasibility using three parameters:

1. **Internal rate of return (IRR).** The IRR for an aquaculture investment project is the discount rate that equates the total present value of the expected cash outflow with the total present value of the expected inflow. In symbols, the IRR is computed as follows:

$$\sum_{t=1}^n \left[\frac{-A_t}{(1+r)^t} \right] = 0$$

$$C_0 = \frac{A_1}{(1+r)^1} + \frac{A_2}{(1+r)^2} + \dots + \frac{A_n}{(1+r)^n} + \frac{S_n}{(1+r)^n}$$

where: C_0 = initial cost of acquiring, developing and operating the project at year 0;

A_t = net cash flows at year t ;

S_n = salvage value at the end of the project;

n = economic life of the project,

r = internal rate of return of the project.

The acceptance criterion is based on a comparison of IRR with a required rate of return (RRR), which generally is the cost of capital. The project is feasible if the IRR is greater than the RRR; otherwise, it is not a feasible project.

2. **Net present value (NPV).** The NPV method discounts all the net cash flows of the project to present value using the required rate of return. The NPV of an aquaculture investment proposal is given by the formula.

$$NPV = \sum_{t=1}^n \left[\frac{A_t}{(1+k)^t} \right]$$

$$+ \frac{A_1}{(1+k)^1} + \frac{A_2}{(1+k)^2} + \dots + \frac{A_n}{(1+k)^n} + \frac{S_n}{(1+k)^n} - C$$

where k = required rate of return.

C = cost

The proposed project is economically feasible if the NPV is greater than zero.

3. **Benefit-Cost Ratio (B/C).** The B/C ratio is the ratio between the total present value of benefits to the total present value of costs. Projects with B/C values greater than one are considered feasible. The B/C ratio is computed as follows:

$$B/C = \frac{\sum_{t=1}^n \left[\frac{B_t}{(1+k)^t} \right]}{\sum_{t=1}^n \left[\frac{C_t}{(1+k)^t} \right]}$$

where B_t = gross annual revenues (including salvage value) at year t ;

C_t = annual operating cost (including initial cost) at year t .

Quantitative assumptions

In the estimation of the annual cash flow of each aquaculture project, the following assumptions were made:

1. Total Revenue (TR)

TR = quantity of each species produced annually x price of each species.

2. Capital Expenditure (CE)

CE = cost of acquiring and developing the farm + cost of equipment: milkfish and shrimp extensive (P100,000/ha), shrimp, semi-intensive (P400,000/ha), and intensive (P500,000/ha).

3. Total Operating Cost (TOC)

TOC = cost of fry + fertilizer + pesticide + feed + labor + electricity + fuel) + interest expenses + income taxes.

4. Net Profit After Taxes (NPAT)

NPAT = total revenue - total operating cost.

5. Depreciation (DEPN)

DEPN = 20% of the values of gates and/or equipment.

6. Income Taxes (IT)

IT = 25% of net profit before taxes below P100,000, otherwise, 35%.

7. Interest Expenses (INTE)

INTE = 25% of loan payable.

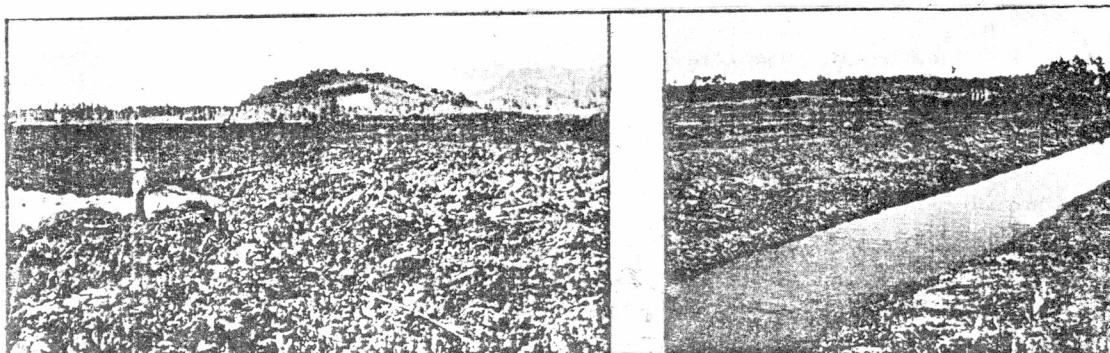
Feasibility of developing mangrove areas for various aquaculture Projects

Milkfish and shrimp are the most widely cultured species in brackishwater ponds in the Philippines. Thus, the evaluation of the feasibility of aquaculture projects in mangrove forests are based on the culture of these species at different levels of management, namely:

Milkfish	(1) extensive	(MNR-ADB, 1983, Code: Pangasinan-13)
	(2) improved	(MNR-ADB, 1983, Code: Iloilo-18)
	(3) extensive with feeding	
Polyculture	(4) improved method with feeding	
	(5) milkfish-shrimp	(MNR-ADB, 1983, Code: Aklan-3)
Integration	(6) Milkfish-salt (Pudadera, 1986)	
Shrimp	(7) extensive	(MNR-ADB, 1983, Code: Capiz-10)
	(8) semi-intensive	
	(9) intensive	(Camacho and Corre, 1986)

Note: Modifications were made in the case studies to provide values of current prices for the cost and benefit.

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Despite strongly acid sulphate soil conditions, well-developed mangrove forests in the Merbok estuary of Western Peninsular Malaysia were cleared for aquaculture in 1981.

Milkfish. With the present market structure of the milkfish industry, both the extensive and the improved method of milkfish farming were found to be not feasible projects. This is indicated by the low IRR (0.0 percent and 2.1 percent, respectively), the negative NPV and the B/C ratio of less than one (0.48 and 0.66, respectively). The IRR of both projects are far below the required rate of return of 25 percent.

Increasing the production twofold by doubling the stocking density and providing for supplementary feeding tended to improve the profitability of both systems, but the projects were still not feasible. The improvement was bigger in the case of the improved method with feeding. The higher IRR of 4.78 percent suggests that this project would become feasible if the cost of capital is 4.78 percent. The B/C ratio of 0.82 suggests that if cost decreases or revenue increases the project could become feasible.

Polyculture. The polyculture of milkfish and shrimp in an extensive system which yielded

0.8 mt of milkfish/ha/yr and 0.07 t of shrimp/ha/yr in a 1.5 ha farm was shown to be economically unacceptable. The total discounted benefits could cover only half of the total discounted costs.

Integration. It was assumed that a 9 ha pond developed for milkfish-salt production would require an initial cost of P1.8 million. This farm yielded 1.6 t of milkfish/ha/yr and 25 t of salt/ha/yr. This alternative proved to be more profitable than the monoculture or polyculture of milkfish. The present market structure of milkfish and salt, however, made the project not feasible unless the cost of capital would decrease to 5.54 percent. The present structure resulted in discounted earnings covering three-fourths of the discounted costs.

Shrimps. The economic analysis showed that the use of mangrove resources for the extensive culture of shrimps, yielding 0.11 t/ha/yr is not feasible. The semi-intensive and intensive culture methods, yielding 5.0 t/ha/yr and 10.0 t/ha/yr, respectively, are, however, economically feasible. The discounted income would recover only 55 percent of the discounted costs for extensive culture. By contrast, the discounted income of semi-intensive and intensive systems was higher than the discounted costs by at least 12 percent. Consistently, the NPV was positive for the latter two systems and IRR (34.3 percent and 39.8 percent, respectively) higher than the cost of capital. The semi-intensive and intensive methods of culturing shrimps therefore, were promising alternative uses for mangrove areas.

Sensitivity analysis

To determine the effects of a change in revenue or cost item on the viability of an alternative aquaculture use of mangrove areas, sensitivity analysis of IRR was employed. Three types of projects which were feasible or showed promise of becoming feasible, were subjected to this analysis.

Milkfish. The economic feasibility analysis showed that milkfish culture, using the improved method with feeding was not economically feasible. The sensitivity analysis showed that this culture method could become viable if capital expenditures fall by 50 percent and the cost of borrowing is

"Research on the prevention and control of shrimp diseases and pond wastes must be undertaken, including studies on the nutritional requirements and feeding behavior of shrimp to improve feeding strategies and formulate cost-efficient pellets."

20 percent. A rise in the selling price of milkfish by 50 percent could generate an IRR of 18 percent, which was still below the required rate. A reduction in the cost of fry or feed by as much as 50 percent could not drastically increase the IRR and the project remained not viable.

Shrimp. The economic feasibility analysis showed that both intensive and semi-intensive culture of shrimp were the most profitable of the aquaculture projects evaluated. These were the only projects found to be feasible under the present market structure. The sensitivity analysis of the IRR, however, showed that both projects could remain viable if the market price of shrimp does not fall by less than 15 percent. The intensive culture of shrimp was more sensitive to a price drop, but the IRR increased at a faster rate as the market price improved. The semi-intensive culture of shrimp remained viable up to about 30 percent increase in the cost of capital while that of intensive culture could take an increase of as much as 50 percent. Because of the use of fewer fry and lower quality feed which was cheaper, the semi-intensive culture was less sensitive to fluctuations of feed and fry cost. In the intensive culture, large increase of IRR were observed with the decrease in feed and fry cost while an increase in the feed cost beyond 30 percent could make the project not feasible.

Implications of the Economic Feasibility and Sensitivity Analysis

Milkfish comprised over 90 percent of the fish produced in fishponds. Today, with the high cost of pond development and the price structure of milkfish, none of the methods of culturing milkfish, was found to be economically feasible. The only milkfish project which exhibited an economic potential was the improved manage-

FLASH! FLASH! FLASH! FLASH!

Eliseo Capistrano, Sr. had a bumper harvest and brisk sale of bangus weeks after the mega-typhoon Rosing devastated most of the fishponds in Pagbilao, Quezon. The reason? His fishponds were protected by mangroves! Aside from making the dikes massive, Mr. Capistrano maintains and protects the thick growth of mangroves that separated his fishpond from the China Sea. The dikes of most fishponds within the area were destroyed by the big waves during the typhoon.

Source: The Manila Bulletin, Jan. 5, 1996

ment technique with supplementary feeding so that higher stocking densities could be sustained. Unfortunately, this is a technology that is still to be developed. Milkfish as one of the most widely eaten fish in the Philippines can greatly influence the prices of the fishes thus, government intervention to increase milkfish production is needed. The analysis showed that this can be done not by expanding the area of brackishwater ponds. A program that can increase the profitability of milkfish farming to make the project feasible includes financing research programs aimed at developing a more intensive and profitable technology, providing lower interest loans and decreasing taxes imposed on profits. Moreover, without providing for a salvage value for the developed ponds, none of the aquaculture projects would be viable on the basis of a feasibility analysis. This suggests that the government needs to compensate for the cost of development of a mangrove leased in case the lease contract is not renewed. Without such programs farmers will continue to lose interest in milkfish culture and would shift to the culture of shrimps and other luxury species.

The economic analysis showed that only semi-intensive and intensive culture of shrimp was profitable. Both these culture techniques do not require vast areas of ponds. Furthermore, for

to next page

not require vast areas of ponds. Furthermore, for certain technical consideration, intensive shrimp ponds are often not built in mangrove areas but are instead built in higher elevation fertile lands beside the sea. This suggests that shrimp production to increase the dollar earning capacity of the country, can increase without having an adverse effect on fish production. It is interesting to note that the attractive price of shrimp today is a factor responsible for the high profitability of intensive culture, even as it requires the highest production cost per kg of shrimp and lower capital costs. Its profitability is less prone to changes in shrimp prices, and the shrimp stock is less prone to the outbreak of diseases. Thus, it is an aquaculture project recommended in certain suitable mangrove areas.

Strategy for the management of Philippine mangrove

The economic feasibility analysis as presented, did not consider trade-offs such as those due to environmental degradation, losses to wildlife, the impact on human health, or social equity distribution of costs and benefits. But in order to consider these, certain quantitative or monetary values need to be assigned to the various alternative uses of mangroves. This has

met many difficulties, such as those that follow:

1. The willingness of the population to pay for the trade-off for a competing activity such as a life-support system would be difficult to measure because of certain limitations. The amount of disposable income, government policy and the education of the people are among the factors that may cause one to prefer something which is not necessarily promoting his health or well-being.

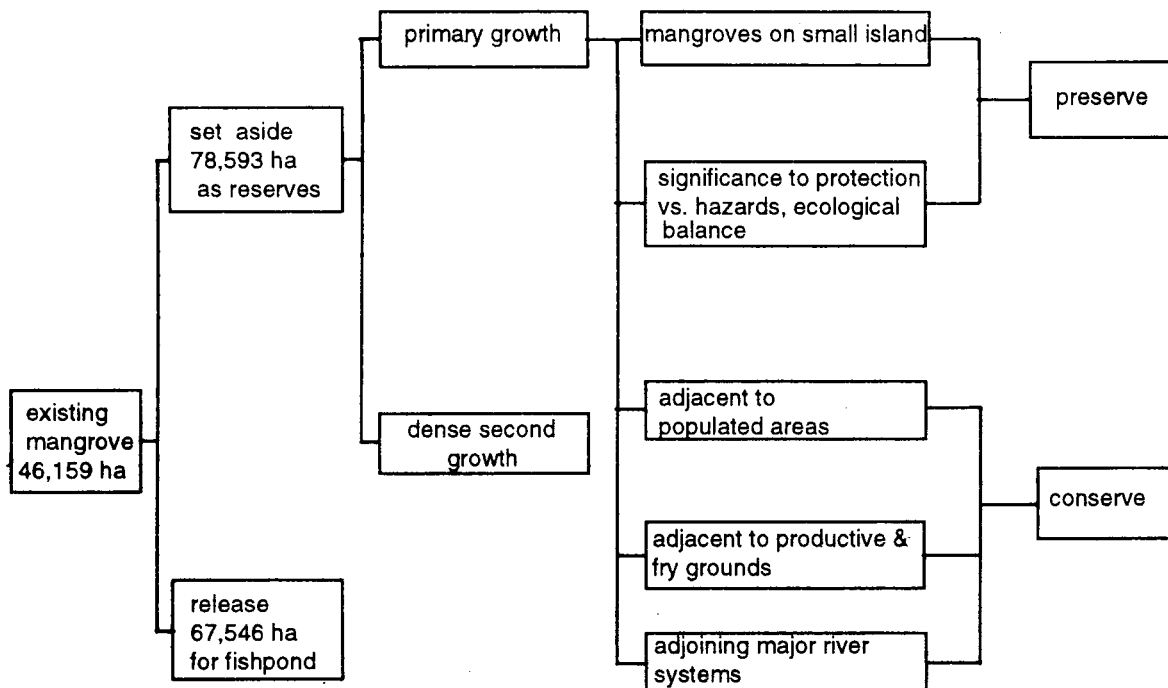
2. It is difficult to quantify the extent of the trade-off of one activity resulting from another activity. For example, the loss of a fishery due to fishpond development cannot be proven, nor can the contribution of fishpond development to the decrease in fishery be quantified.

3. The value of mangrove for various competing uses is site-specific. For example, its value for pollution control or for residential use is higher in population centers than in less populated areas. Thus, the tremendous advantage of preservation demonstrated by some is actually site dependent.

If more mangrove areas are to be allocated for fishpond development, then, one alternative action that can be used for the site selection is the one proposed by P. Zamora in 1981 as shown below.

During the last few years, with the permis-

Guidelines for the selection of mangrove areas for preservation, conservaiton and fishpond development



age system, vast areas of the remaining mangrove forests have been destroyed for conversion to fishponds. Many of these areas had very low production or were eventually confiscated by banks because of inability to keep up with loan payments. This is a sign of either mismanagement of the loans or of the lack of economic feasibility. Results of the economic feasibility analysis showed that in the recent years, the latter is likely to happen. Concern over the low profitability and low yields of milkfish farming have been demonstrated recently. This can be attributed to the reduced per capita fish consumption resulting from declining real wages and inflation, as the cost of inputs increases.

The only way for aquaculture ventures to become feasible and more profitable is to go intensive. Thus, for both economic and ecological purposes, it is concluded that no additional mangrove forests should be allocated for fishpond development. Strict enforcement to restrict further conversion of mangrove forests to fishponds should be practiced. For purposes of equity in benefits of areas already allocated for fishpond development, the lease contract should be terminated for violators of the agreement and the area redistributed in smaller parcels.

Logging in mangrove forests has become less important since 1971 so that today, it is of little economic value. It is therefore evident that leaving these forests as reserves can provide the population with tremendously higher returns in terms of benefit as wildlife sanctuary, pollution sink, nutrient enrichment, nursery and breeding ground and maintenance of sustained yield of brackishwater fishes and marine fishes, shoreline protection and natural land reclamation, among others. Benefits as such were estimated to be twenty-five fold higher than the direct benefits of paddy cultivation in India. If losses or decreases in these benefits would have entered as indirect costs in an extended benefit-cost analysis, the case against the conversion of mangrove forests to fishponds would have been further strengthened.

Source: Chiu, YN, BC. Posadas and VJ Estilo. Strategy for a cost/benefit analysis in the conversion of mangrove areas to aquaculture. UP in the Visayas, Iloilo City.

'Mangrove forests as reserves can provide the population with tremendously higher returns in terms of benefit as wildlife sanctuary, pollution sink, nutrient enrichment, nursery and breeding ground and maintenance of sustained yield of brackishwater fishes and marine fishes, shoreline protection and natural land reclamation.'



What needs to be done?

Pond culturists should be encouraged to practice semi-intensive farming because it is more economically and ecologically viable. Immediate and massive reforestation of denuded mangrove habitats, enforcement of existing legislation, and promulgation of new laws also should be undertaken. Where remaining mangroves are subject to population pressure, aquaculture tech-

nologies that are environmentally sustainable and that allow conservation of the resource may be introduced.

As mentioned in the AFN July-August 1995 issue, recommendations include: **conservation and reforestation**, (*see guide below*) **promotion of ecologically sound aquaculture**, and **legislation and enforcement**.

Guide in mangrove reforestation

Zonation. Zonation is a vital guide in mangrove reforestation in determining what species are particularly suited to plant in a particular site.

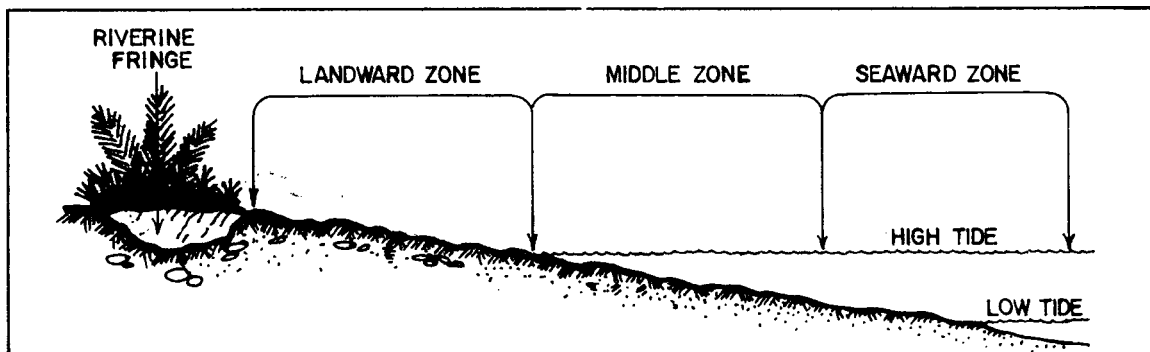
1. **Seaward zone** - refers to the portion of the swamps daily affected by tidal inundation including neap tides; species found are generally called frontliners and are the true mangrove type; soils range from sandy to sandy loam, mudflat or corraline type.
2. **Middle zone** - refers to portion of mangrove swamps affected daily by tidal inundation except during neap tides. Soil is generally clay, silty to silty-clay.
3. **Landward zone** - is the back portion of the mangrove swamps which usually remains unaffected by tidal inundation over a long period except during exceptional high tides called "spring tides." Soil is generally clay to silty clay. Vegetation is highly diverse due to the presence of mangrove associates, vines and epiphytes.
4. **Riverine fringe** - are those portions of the swamps along the river system.

Plantation Establishment. The following factors must be considered in the establishment of mangrove plantation:

A. Identification of the species. There are several species of mangroves which are widely preferred and planted because they are (1) easily available, (2) easy to plant, grow and maintain with high economic value, and (3) market demand.

B. Selection of planting site. In selecting planting site, the following factors must be considered: soil, water depth and tidal inundation, exposure from sun and wind, and absence of barnacles.

C. Preparation of the planting sites. Determine the area to be planted and divide it into blocks for easy planting (a space of 7-10 m sea lane shall be provided in between blocks for the passage of banca and other users). Then stake the planting area and surround it with fence. Remove the debris brought in by tidal inundation.



The four distinct zonal distribution of plants in mangrove areas

D. Seed collection. Collect mature and healthy seeds from the nearest source with similar climatic condition. It is best to collect mature seeds while still attached to the mother tree.

E. Handling and transporting of seeds. If possible, retain the pericarp (the brown-like structure enclosing the plumule) to protect the young shoots during handling and transport. Cover the seed with moist gunny sacks of coconut leaves to avoid drying. Keep the seeds in horizontal position.

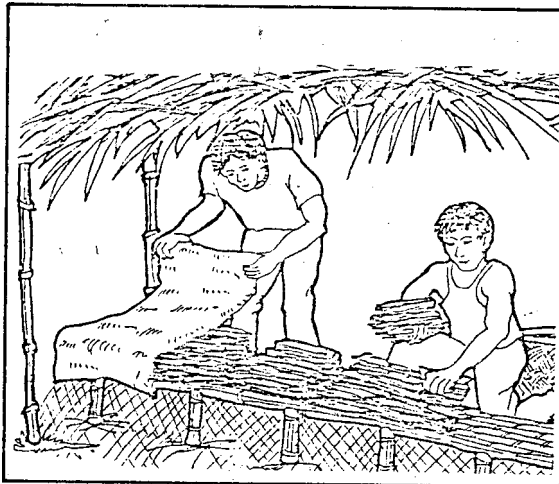
F. Planting

Direct Planting. Direct seeding is recommended to entail less labor and cost. On soft grounds, direct seedings are done through simple planting at $1/3$ to maximum of $1/2$ of the total length of the hypocotyl. Make holes first on hard grounds and plant $1/4$ or $1/3$ of total length of hypocotyl buried.

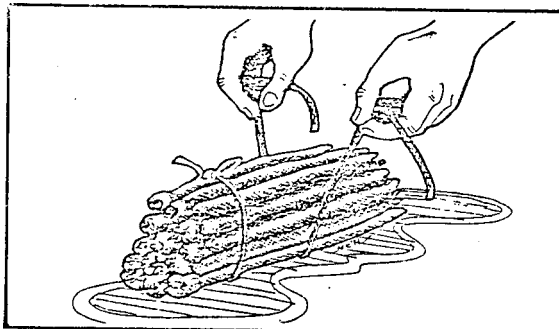
Spacing. The best spacing is $0.5\text{ m} \times 0.5\text{ m}$ with single thinning operation to be conducted at the end of the fifth year to the tenth year.

Timing. Planting should be in proper timing with (1) availability of mature seeds, (2) calm weather, and (3) extensive and longer hours of low tide.

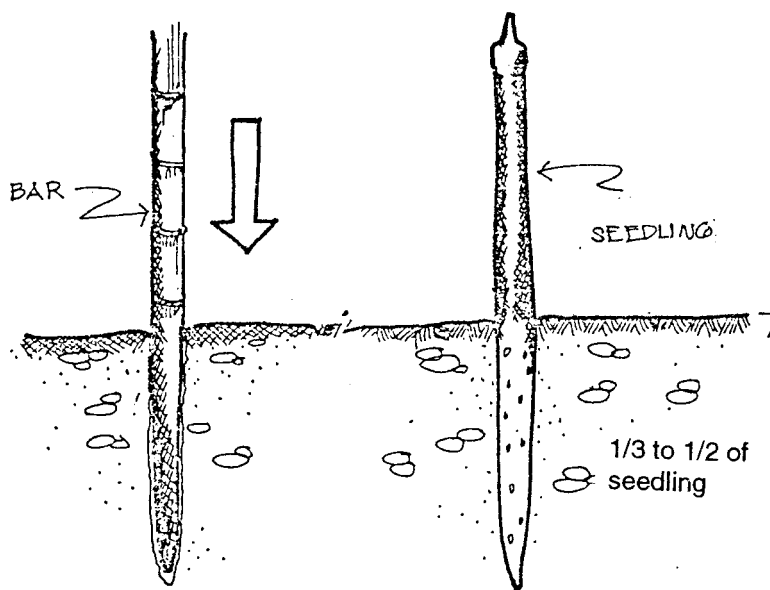
And most importantly, protect and manage properly your mangrove plantation!



Keeping the seeds under the shed and covering them with gunny moist sacks.



Bundling the seeds for better counting and handling



The recommended measurements for direct seeding

Source: *Guide in Mangrove Reforestations* Techno-Transfer Series, DENR-ERDS, Region VI, Iloilo City, Mar-Apr 1990, Vol. 1 No 2.

Aquaculture clinic

Q: *Our mangroves are in a very sorry state yet the rich continue to destroy them in favor of fishponds. Why is our government not keen about protecting our mangroves? Is there any law protecting them?*

A: The Department of Environment and Natural Resources (DENR) has finally banned the conversion of mangroves into fishponds through Administrative Order No. 15. The Order prohibits the conversion of mangrove forests and regulates the use, development and management of the country's remaining mangroves. Under the policy, the government stops issuing permits and immediately convert abandoned and unused mangrove swamps back to their original forest-land classification.

In addition, it has also stipulated provisions giving the government the prerogative to pull out existing and unproductive fishponds from these areas. The Department said operators will be compensated, but the areas will be declared off-limit to further use for aquaculture development.

The DENR has limited fishpond development to denuded areas zoned as suited for such activities. Even estuarine mangroves that are predominately vegetated by shrubs will not be disposed for fishponds. The shrub coastal areas will instead be subject to intensive rehabilitation.

The Order also allows the establishment of mangrove plantation forest lands and alienable and disposable areas. This provision allows an initial maximum area for plantation development of 50 ha for corporation, cooperatives and associations and 10 ha for individuals for plantation development. Additional areas may be granted to existing developers provided that their accumulated area will not exceed 200 ha and 50 ha respectively.

The DENR Order will supersede existing restrictions and instead impose the conversion ban, but government will still use certification of Stewardship Contracts for community-based activities aside from mangrove plantations. The Department said these contracts will not cover fishpond and paddy development.

Source: The Manila Times, March 3, 1990

from page 8...

Mangroves protect the ponds built behind them and influence considerably the water quality in shrimp farming areas. Mangroves may remove nutrients, heavy metals, suspended solids, and toxic hydrocarbons. Thus, coastal water quality may deteriorate through loss of the mangroves' filtering capacity. Conversely, mangroves can "clean-up" shrimp pond effluent.

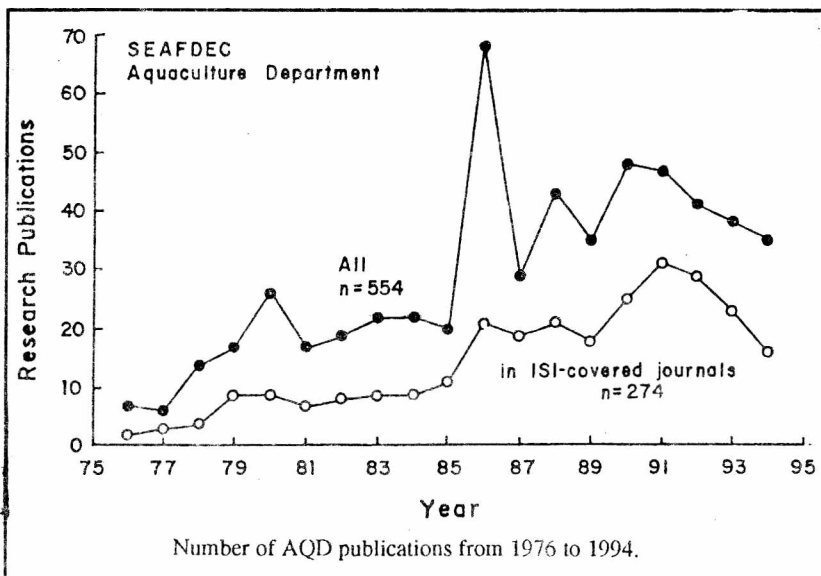
There are mutually supportive functions of aquaculture and mangroves and there is now growing interest in integrating mangrove and shrimp farming in the coastal zone. If the benefits of mangroves to sustainable shrimp culture are

more clearly recognized, shrimp farming may provide an additional economic justification to preserve mangroves. In Indonesia, Thailand, and the Philippines, a mangrove buffer zone between the sea and the shrimp ponds has been advocated. Such zones can potentially serve the interests of both the conservationists and the shrimp farmers. In Thailand, large private farms retain a protective mangrove buffer.

Source: Bagarinao, TU and EC Flores. Eds. Towards Sustainable Aquaculture in Southeast Asia and Japan. Proc. of the Seminar-Workshop on Aquaculture Development in Southeast Asia. 26-28 July 1994. p. 38.

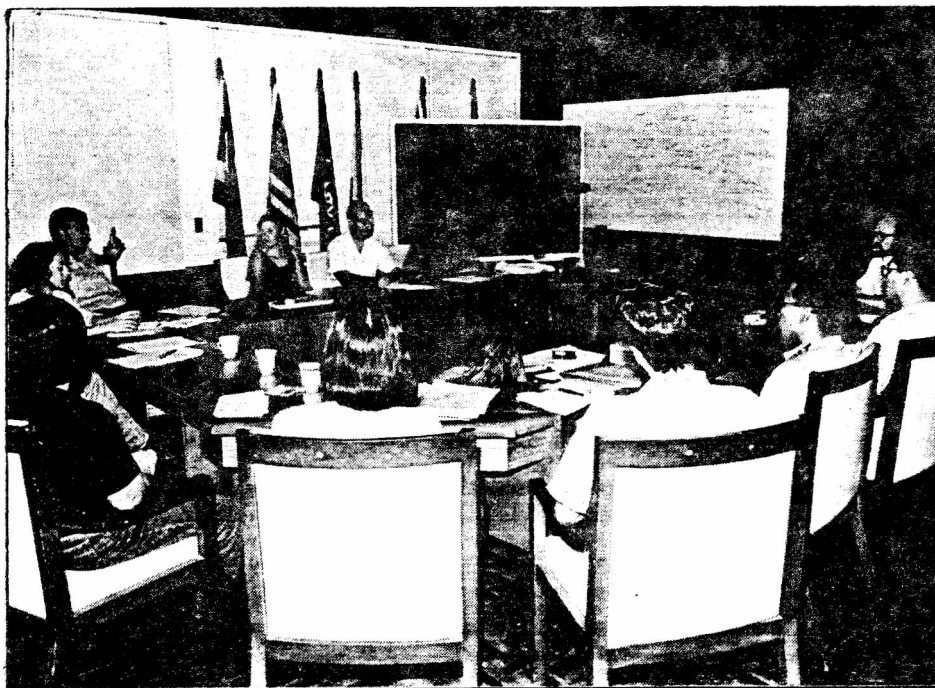
SEAFDEC/AQD bares accomplishments in 2 decades

After 21 years, AQD researchers produced 554 publications. This includes 274 in journals indexed by Institute for Scientific Information (ISI), 122 in other journals, and 158 in conference proceedings. Another 82 publications from work done outside AQD were authored or co-authored by AQD researchers, mostly during their graduate (theses) programs. AQD published also 21 extension manuals and 14 technical reports and monographs. The figure shows the breakdown of these publications by year, together with the subset of papers published in ISI-covered journals. The difference between the two curves represents the papers in other journals and in proceedings.



After two decades, AQD continues to promote aquaculture within the context of sustainable development.

The 554 publications were tallied by year, aquaculture commodity, and research topics.



Participants in the Lake Modelling Course conducted in Tigbauan Main Station on 4-12 January 1996. The European participants are from Hohenheim University, Hamburg University, Padua University and the Royal Danish School of Pharmacy. Philippine participants are from AQD and University of the Philippines.

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AFN is a production guide for fishfarmers and extension workers. It discusses the technology for cultured species and other recent information excerpted from various sources.

In citing information from AFN, please cite the institutional source which is not necessarily SEAFDEC/AQD. Mention of trade names in this publication is not an endorsement.

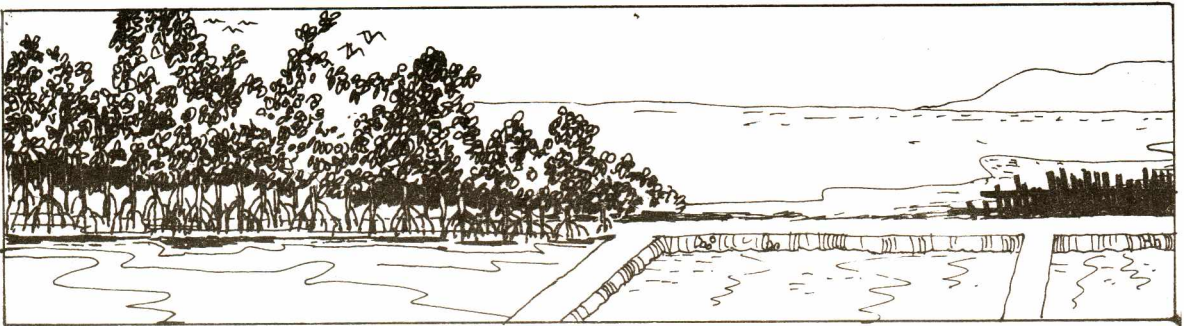
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Mangroves or ponds? Why not both?



E. LEDESMA



Better life through aquaculture